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PATENT ABSTRACTS OF JAPAN

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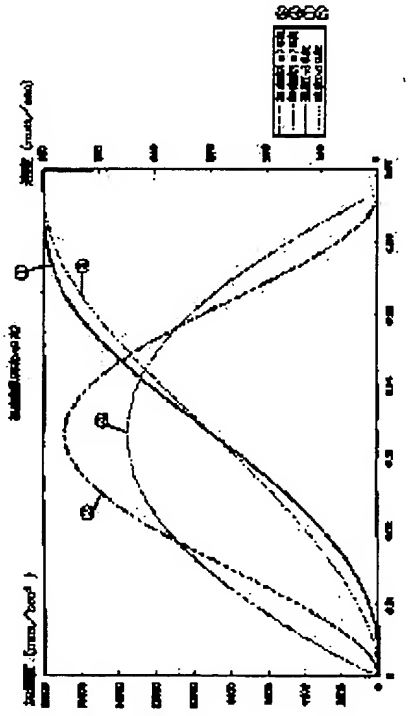
(54) METHOD FOR CONTROLLING ACCELERATION OF MOTOR

(57)Abstract:

PROBLEM TO BE SOLVED: To smoothly accelerate a motor and, at the same time, to reduce the overshooting of the motor after the rotating speed of the motor reaches a target speed, by issuing an order so that the acceleration change of an object to be controlled may become continuous and smooth or the differential change of the acceleration may become continuous in accelerating a mechatronic device which uses the motor as its driving source.



SOLUTION: In the acceleration graph, the peak of an intermediate acceleration is large as compared with the position (4), but it can be said that the acceleration continuously changes, because the acceleration gradually increases after the acceleration is started and gradually returns to '0' after the acceleration is completed. Since the driving force which makes the acceleration trace this speed variation curve continuously changes the acceleration as shown by curve (2), an object to be controlled can be controlled in a more natural low-loss state. In addition, when a 'speed command value' is given by the quintic functional speed variation curve (1), led to a target speed of 600 mm/sec, and simulated, the spot where the speed changes in steps during acceleration becomes smoother and the overshooting of a motor also becomes smaller after the rotating speed of the motor reaches the target value.

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* NOTICES *

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the motorised acceleration control method of all equipments, such as a serial formula ink jet printer and scanner equipment.
[0002]
[Description of the Prior Art] About the conventional acceleration control using the motor, the carriage scanning drive of a serial formula ink jet printer recording device is mentioned as an example, and is explained.
[0003] Drawing 2 explains the carriage drive using the DC motor. The scanning drive (arrows A and B) of carriage 151 which carried the recording head is performed by DC motor 152 fixed to the chassis (un-illustrating) of a recording device. It is the composition of combining the drive pulley 153 with a motor shaft, laying the rubber belt 155 with a gear tooth between the idler pulleys 154 formed in the opposite side of the scanning zone of carriage 151, fixing a rubber belt to the part which was prepared in carriage 151 and belt stopper 151a Becoming, and changing it into scanning operation of carriage for rotation of a motor as rotation operation of a belt.
[0004] The idler pulley 154 was attached in the pulley electrode holder (not shown), in the direction (arrow C) opposite to a motor, with the belt tension spring (not shown), could give the force and has given tension to the rubber belt. Moreover, a pulley electrode holder may be fixed to a chassis.
[0005] 156 -- a linear encoder scale -- it is -- here -- for example, 360 lpi (a line par inch, 25.4mm / 360= 70.6 micrometers) -- it is -- etc. -- the position of carriage 151 is correctly acquirable by detecting the mark prepared in the interval by the encoder sensor 157 fixed to carriage 151 Optical and a magnetic formula are used as a method of an encoder. Moreover, at the time of the scan of carriage 151, the speed of carriage is computable from the time interval of continuous detection of the mark of a linear encoder scale.
[0006] Drawing 3 is a ** type view explaining the carriage scan speed control system of the conventional serial formula ink jet printer. A DC motor is controlled by technique called PID control or classic control. The procedure is explained.
[0007] First, target speed to give carriage 151 is given in the form of "speed instructions." "Speed instructions" has the common form which is made to increase at a fixed rate and is led to target speed as shown in the form where begin by constant value as shown in (a), and shell target speed is given, or (b).
[0008] Moreover, a speed conversion circuit computes the "scan speed" of the present carriage from the signal of an encoder sensor, and the clock built in the printer. The numeric value which subtracted the "scan speed value" from the "speed instruction value" is delivered to a "PID arithmetic circuit" as insufficient "speed error" to target speed, and the energy which should be given to a DC motor at the time is computed by the technique called "PID operation." As motor applied voltage being fixed, by changing the pulse width of applied voltage, the "motor driver circuit" which received it changes Duty of (it is called "PWM (Pules Width Modulation) control" below) and applied voltage, adjusts current value, adjusts the energy given to a DC motor, and performs speed control in this example.
[0009]
[Problem(s) to be Solved by the Invention] In recent years, progress of the quality of image of a color ink-jet recording device is remarkable, and high definition-ization to the extent that it is called

"photograph quality of image" is required increasingly. The demand of a raise in resolving also increases for high-definition-izing, and the thing of the resolution of 1440dpi is also commercialized for what was about 360 dpi several years ago now.

[0010] In the resolution of 360dpi, the performance for which the impact precision is asked is increasing in "micron order" in the ink-jet recording method which the interval of the contiguity dot which was 70.6 micrometers is narrow with 17.6 micrometers (=25.4mm/1440) in 1440dpi, drives in the ink drop of a different color in a predetermined field, and expresses a color.

[0011] In an ink-jet recording method, in order to raise ink drop impact position precision to a limit, it is necessary to bring recording head scan speed change close to zero infinite. The speed of carriage in case an ink drop is breathed out is because an ink drop trajectory is decided and an impact position is affected.

[0012] Especially immediately after the scanning start, it was not completed by speed change immediately after reaching a predetermined scan speed, but, for the reason, the ink drop impact precision in the edge of a record form fell, improvement in printing grace was barred, and it was inconvenient.

[0013] It is the graph of drawing 4 which was raised as the example. This graph is the result of carrying out a simulation by MatLab/Simulink of Cyber-Network Systems. A vertical axis is speed, a horizontal axis is elapsed time, the fixed speed instruction value is inputted from time 0sec, and a solid line is change of the scan speed of carriage. In this example, "speed instructions" is the methods of giving 600 mm/sec of target speed as constant value from the start. After reaching 600 m/sec of target speed, it turns out that speed is changing in vibration.

[0014] In order to suppress small the speed change by the disturbance after converging on target speed, it is necessary to raise the gain of a PID arithmetic circuit in the range which does not spoil the stability of a system as much as possible. However, if gain is raised by the method of giving speed instructions by constant value as mentioned above, too much, since going too far (it is called an over shoot) after accelerating with big acceleration superfluously and reaching target speed will become large unnecessarily, a vibration speed change occurs after an over shoot, and speed change in an acceleration region is large, and considering the ink impact precision in the place, it is inconvenient.

[0015] Moreover, in the latest ink jet printer, as for an ink tank, carrying in carriage is common, and its model which also carries LM with thin concentration (light MAZENDA) and LC (light cyanogen) ink to the former besides Bk (black), Y (yellow) and M (MAZENDA) which were required for color printing, and C (cyanogen) ink 4 color for high-definition-izing has been increasing. Moreover, ink tank capacity is becoming large gradually for the ink tank cost reduction per one-sheet printing. Therefore, the weight of carriage is increase-ized, noise is emitted [if unnecessary acceleration is given, the whole equipment will vibrate by the counteraction, or], and it is inconvenient.

[0016] In order that carriage may print, the field which can be scanned by constant speed is called fixed-speed field, and the field which has expected and taken a distance required for this side for acceleration is called acceleration/deceleration space. Although printing can be simply started after acceleration is made small and a scan speed is fully stabilized if an acceleration/deceleration space long enough is taken, there is a severe demand. That is, taking the aforementioned long acceleration field in a serial method printer is directly linked with a full expansion of printer equipment. Although it is improvement in printing grace, low noise, and a reason of low vibration, it is inconvenient to take a long acceleration/deceleration space and to enlarge equipment these days which has all equipments towards downsizing.

[0017] Next, drawing 5 is the method of making increase a "speed instruction value" at a fixed rate, and leading to 600 mm/sec of target speed, and is the result of carrying out a simulation by MarLab/Simulink. (Parameters other than speed instructions are made the same as drawing 4 .) The rate of the increase in a speed instruction value is 20mm of 0.0666secx600 mm/sec/2= 20mm scanning distance, and it is set up so that target speed (600 mm/sec) may be reached as it understands by the following formulas. The dashed lines in a graph are speed instructions, and a solid line is change of the scan speed of carriage. In this case, since control works so that the scan speed of carriage may trace the inclination of speed instructions, it does not accelerate early more than required. However, it turns out that there is a stair-like part where speed falls [a scan speed] speed instructions slightly the

circumference of the upper in the middle of acceleration as a graph also shows. If there is such a thing, the smoothness of acceleration is spoiled, this also causes a vibration speed change, and it is inconvenient.

[0018] Although it is the open control which uses PM motor for the carriage scanning drive of the ink jet printer of BJP4000 system which an applicant manufactures, in order to realize smooth acceleration too, the 3rd function curve is applied to the acceleration table. This idea is applied to the control which made the DC motor the driving source, and it explains. That it is the origin of this idea tends to increase an increment gradually rather than it tends to make a speed instruction value increase at a fixed rate, it tends to have the peak of the amount of increments by the way point of acceleration, tends to reduce gradually from there again, when reaching target speed, it tends to set the increment of speed to 0, and it tends to smooth acceleration start and the completion of acceleration.

[0019] Drawing 6 is the method of giving a "speed instruction value" with a 3rd function curve, and leading to 600 mm/sec of target speed as mentioned above, and is the result of carrying out a simulation by MatLat/Simulink. In addition, parameters other than speed instructions are made the same as drawing 4 . It is not enough, although some parts which were seen by drawing 5 and where speed change showed the shape of a stairway during acceleration become smooth and an improvement is found.

[0020] Next, how to ask for a 3rd order functional speed change instruction curve is explained. For example, conditions are assumed as follows.

(a) Initial velocity is 0 mm/sec.

(b) Acceleration is completed by 20mm scan.

(c) Target speed is 600 mm/sec.

(d) The acceleration at the time of an acceleration start and the completion of acceleration is 0.

[0021] When speed (v) is set with v=at3+bt2+ct+d as 3rd function of time (t), it is t= 0 from conditions (a), and is v= 0, therefore since it is the differential of speed, d= 0 acceleration (alpha) is t= 0 from alpha=v'=3at2+2 bt+c conditions (d), and is alpha= 0. Therefore, it is the completion time of c=0 acceleration t1 It carries out. From conditions (d), it is t=t1. It is alpha= 0. It follows. 0=3at1 2+2bt1 ..... It is t=t1 from ** conditions (c). It is v= 600. It follows. 600=at13+bt12 ..... Since it is the integration of speed (v), ** scanning distance (x) is t=t1 from x=integralvdt=(a/4) t4+(b/3) t3 conditions (b). It is x= 20. It follows. 20=(a/4) t14+(b/3) t13 ..... It will be set to t1 =1/15, a=-4050000, and b= 4050000, if ****, **, and ** formula are allied and it solves.

[0022] Drawing 7 is a typical graph about change of the scanning distance (x) expressed with the formula of the 3rd order functional speed instruction curve for which it asked as mentioned above, speed (v), and acceleration (alpha). To be sure, if these are considered, if the graph of speed is seen, compared with the method to which speed is made to increase at a fixed rate, for an acceleration start, speed will increase gradually and target speed will be smoothly followed near the completion of acceleration.

[0023] However, in the graph of acceleration, it increases from acceleration 0 rapidly by acceleration start, and in the completion of acceleration, it has returned to 0 rapidly and it must be said that it is discontinuous. As everyone knows, since it is F(driving force) =M(mass) xalpha (acceleration), if a speed instruction curve functional the 3rd order is given, it will be required that how to give driving force like the graph of the acceleration of drawing 6 should be adopted. Driving force will change discontinuously at the time of an acceleration start and the completion of acceleration, and jamming spoils the smoothness of acceleration as a result, is considered to have brought a result puffed up in the over shoot after reaching target speed, and is inconvenient.

[0024] Therefore, the purpose of this invention is to offer the motor acceleration control method that the over shoot after reaching target speed can be decreased while accelerating smoothly.

[0025]

[Means for Solving the Problem] the driving force to which it is giving with the 5th order functional curve mentioned later in detail typically, and a driving source emits an "acceleration table" by the closed loop control using the DC motor etc. as the working-speed control method at the time of acceleration of carriage at this invention at the time of acceleration by the open loop control using the stepping motor etc. for the "speed instruction curve" in order to attain the above-mentioned purpose -- "from driving force 0 -- continuous -- and -- smooth -- " -- it constitutes so that it may change

[0026] In the carriage speed control of this invention constituted as mentioned above, since change of

the force which realizes acceleration is "continuous and smooth", few acceleration control of a loss is attained and, specifically, the vibration at the time of - acceleration and noise can be suppressed.
- The oscillating speed change at the time of acceleration can be suppressed, and contribute to improvement in ink impact precision, and improvement in printing grace.
- Since speed change convergence at the time of acceleration is brought forward and it contributes to shortening of an acceleration field, the miniaturization of equipment is attained.
- The PID gain in an acceleration field can also be set up highly enough, and contributes to it bringing speed change convergence forward.
The said effect is acquired.
[0027]
[Example] Hereafter, the serial formula ink-jet recording device of the example 1 of this invention is explained in detail with reference to a drawing.
[0028] Drawing 8 is the appearance perspective diagram of the ink-jet recording device of the example 1 of this invention, drawing 9 is a fluoroscopy perspective diagram explaining the function of each part of an ink-jet recording device, drawing 10 is drawing of longitudinal section of ink-jet recording device explanation, drawing 11 is scanning-zone explanatory drawing of the carriage of an ink-jet recording device, drawing 12 is the external view and elements on larger scale of BJ cartridge of an ink-jet recording device, drawing 13 is the recovery system unit configuration view of an ink-jet recording device, and drawing 14 is the block diagram showing the composition of the electric section to the Lord of an ink-jet recording device.
[0029] Hereafter, the ink-jet recording device of the example 1 of this invention is explained using drawing 14 from drawing 8 . In drawing 8 , 1 is a part which sets printing media (form) collectively by the cut sheet feeder. As for 2, it is straightly fed with reliance and printing media per left-hand side of a form in a sheet guide. It is the part by which the media which printing by the exhaust port of 4 ended are discharged. 5 can hold the media which printing ended on the delivery tray to dozens of sheets. 6 has arranged the power supply button, the online button, etc. with the control panel. By the front cover, 7 is opened, when removing the media got blocked, the time of exchange of the BJ cartridge 19 (refer to the 12th view), and.
[0030] In drawing 9 , 8 plays the role which sends out at a time one media set to the cut sheet feeder 1 with the pickup roller. After the driving force which is a feed motor and is generated here is slowed down by the slowdown gear 10, 9 is transmitted to a feed roller 11 and rotates a feed roller 11. 12 is a PURESHA roller, is a roller without a drive, and the pressure welding of it is carried out to the feed roller, and it follows. The form sent out to the position where the feed roller 11 and the PURESHA roller 12 touched with the pickup roller 8 is sent by the conveyance force of a feed roller 11 from there. 13 discharges the media which printing ended with the ejection roller on the delivery tray 5. 14 is a spur, the role which carries out the pressure welding of the media to the ejection roller 13 is played, and the configuration is devised so that the ink which is not established after printing may not adhere.
[0031] 19 is the unit equipped with the recording head and the ink tank by BJ cartridge. 151 is carriage, it is the parts which carry the BJ cartridge 19, and the attachment and detachment are constituted so that easily. 20 is a guide shaft, 21 is a guide rail, and the posture of carriage 151 is supported.
[0032] Carriage 151 is being fixed to one place of the carriage belt 155. The carriage belt 155 is laid with the drive pulley 153 and the idler roller 154 linking directly to the carriage motor 152. The DC motor is used for the carriage motor 152.
[0033] 156 -- a linear encoder scale -- it is -- here -- 360 lpi (a line par inch, =25.4mm / 360= 70.6 micrometers) -- it is -- etc. -- the position of carriage 151 is correctly acquirable by detecting by the mark prepared in the interval Moreover, at the time of the scan of carriage 151, the speed of carriage is computable from the time interval of continuous detection of a linear encoder scale. The BJ cartridge 19 performs horizontal-scanning operation with the driving force generated by the carriage motor 152 this composition.
[0034] 22 is a recovery system unit and is equipped with the pump 24 which gives negative pressure to a recording head and attracts the ink in a recording head, and the blade 25 which carries out wiping of the recording head side which became dirty by printing in equipment through the cap 23 who prevents dryness of a recording head at the time of printer un-using it, and the cap 23. In addition, signs 23, 24,

and 25 are explained in relation to drawing 13 .
[0035] In drawing 10 , two or more printing forms 45 loaded into the cut sheet feeder 1 are sent out to the position of a feed roller 11, when a pickup roller 8 rotates two times. A control board 111 is then told about a state by intercepting the pickup roller sensor 46 whose pickup flag 42 formed in the pickup roller 8 is a photosensor. Then, it is conveyed by a pressure roller 12 and the feed roller 11 as above-mentioned. 44 is a transfer roller and tells the drive of the field roller 11 to the ejection roller 14. The BJ cartridge 19 is arranged the upper hit of the transfer roller 44, and it has become a printing field.
[0036] And the form which printing ended is discharged by work of a spur 14 and the ejection roller 13. When it is arranged at the upstream of a feed roller 11 and a form is there, a paper and a flag 43 intercept a paper and a sensor 41, and tell a control board 11 about it. If the form back end separates from the position of a paper and a flag 43, a control board 111 will perform printing of a predetermined line from there using the information from a paper and a sensor 41. And it is not based on the existence of the data in the time, but a form is discharged compulsorily.
[0037] Carriage 151 is being fixed to some carriage belts 155. The encoder sensor 157 fixed to carriage 151 detects the mark of a linear encoder scale.
[0038] Drawing 11 explains the assignment in all the scanning zones of carriage. Most of "all scanning zones" becomes a "printing field." In this range, being stabilized at the rate of predetermined, being able to run, and scanning within the fixed speed range of fluctuation, carriage breathes out an ink drop from the carried recording head, and performs printing.
[0039] There is an "acceleration-and-deceleration region" in the both sides of a printing field. When printing at the "printing field" full, the slowdown for the acceleration to a predetermined speed and scanning-direction reversal is completed in this "acceleration-and-deceleration region."
[0040] A "wiping field" is a field which carries out operation which the nozzle forming face of the blade and recording head in the below-mentioned recovery system unit contacts, and removes the adhering ink drop. Moreover, reserve **** is also performed in this field.
[0041] Although a recording head is covered and protected by the cap 23 in a recovery system, carriage 18 needs to be in the "home position" of the right end in drawing then. Moreover, carriage is set to this "home position" after end operation at the time of a power supply OFF.
[0042] Drawing 12 contains the appearance perspective diagram (A), recording head section enlarged view (B), and nozzle section enlarged view (C) of the BJ cartridge 19. The BJ cartridge 19 consists of ink tank section 19a and recording head section 19b. It is the cartridge which can be printed full color including black, cyanogen, MAZENDA, and the ink tank of four colors of yellow. Nozzle train 19c is prepared in recording head part 19b. An ink drop is breathed out from here and it records on a form. 19d is a head face side which forms the nozzle. As shown in a nozzle section enlarged view (C), nozzle train 19c is located in a line with the single tier, and the interval is 1/720 inch and about 35.3microM. 320 nozzles are formed in all and, for black and No 145-192, cyanogen and No 209-256 are [No 1-128 / MAZENDA and No 273-320] the nozzles of yellow. Moreover, although No 129-144, No 193-208, and No 257-272 are the nozzles of a dummy and these nozzles are formed, the supply way of ink is not connected to an ink tank. The ink of the color which adjoined which adhered to the head face side on the occasion of wiping has mitigated the phenomenon of entering in a nozzle.
[0043] At this example, when the discharge condition of the BJ cartridge 19 gets worse, the 320 above-mentioned nozzles are covered with one cap 23, and ink is simultaneously attracted from all nozzles by decompressing the inside of a cap 23.
[0044] 19d is a head face side which forms nozzle train 19c. As shown in drawing 12 (B), 19d of head face sides is abbreviation flatness, and a pressure welding is carried out, and they are stuck so that a cap's 23 nozzle train 19c may be covered, and carry out ink suction.
[0045] Drawing 13 is the block diagram of the recovery system unit 22. Drawing 13 (a) is an upper surface block diagram. The cap electrode holder with which 23 is supporting the cap and 26 is supporting the cap 23, and 24 are pumps. If carriage 151** scans on a recovery system unit in the state of drawing, wiping will be carried out, it is a blade, 25 can be slid in the direction shown in an arrow, and when wiping is unnecessary, it evacuates. 31 is a recovery system motor and is vertical operation of a cap 23, slide operation of a blade 25, and the driving source of a pump 24.
[0046] Drawing 13 (b) is the cross-section block diagram seen from A arrow back of drawing 9 . The

pressure welding of the cap 23 is carried out to the recording head section of the BJ cartridge 19. The cap electrode holder 26 is directed free [rotation] focusing on the supporting point. 27 is a cap spring and has given the cap 23 the contact pressure through the cap electrode holder 26. It is a cap release cam, and 28 is making it the position rotated 180 degrees from the state of drawing, it presses the cap electrode holder 26 and cancels a cap's 23 pressure welding.

[0047] 29 is a tube and is connected to a cap 23 through the pipe section prepared in the cap electrode holder 26. The tube 29 passes along the inside of a pump 24, has a tube pump generally said and is carrying out pump composition. It is methamphetamine PUKORO, and 30 is rotating in the direction of arrow d, it can draw a tube 29 through, can lower the atmospheric pressure in the cap 23 who has connected, and can suck out the ink in the BJ cartridge 19.

[0048] In drawing 14 , 111 is a control board which is controlling each part of this equipment. 100 is MPU which receives a signal from each part, emits a control signal to each part with the signal, and is controlling the whole equipment. ROM in which 101 stored the control-procedure program, RAM for which 102 is used as a work area at the time of control execution, The timer for 103 measuring time, nonvolatile data-hold meanses (EEPROM etc.) by which 104 memorizes accumulation record number of sheets, the amount of waste ink, etc., and 105 The interface section which exchanges a signal with hosts, such as a computer The indicator section which 106 tells to a user that the situation of this equipment is, and 107 An electric power switch, The key switch operated in order that a user including an online switch etc. may give an instruction to this equipment, and 108 are drivers which drive the carriage motor 152, change Duty of ON/OFF, and the voltage of pulse width suitable for the state is given to a motor.

[0049] The signal detected by the encoder sensor 157 is passed to MPU, and is changed into the position of carriage 151, or the information on speed. The driver with which 109 drives the paper feed motor 9, the driver with which 110 drives a recording head, and 112 are drivers which drive the recovery system motor 31.

[0050] Drawing 1 is a graph which shows the speed instruction curve of carriage scanning acceleration control and acceleration change in the serial formula ink jet printer of the example 1 of this invention. Within the graph, the 5th order functional velocity curve is shown as an example as compared with the 3rd order functional speed change curve which is a "Prior art" and was already explained.

[0051] ** It is acceleration change when a 3rd order functional speed change curve and ** show 3rd order functional speed change. For an acceleration start, speed of a speed change curve increases gradually, and it is following target speed (600 mm/sec) smoothly near the completion of acceleration. However, in the graph of acceleration, since it increased from acceleration 0 rapidly by the acceleration start, it has returned to 0 rapidly in the completion of acceleration and it becomes acceleration 0 henceforth, it must be said that it is discontinuous.

[0052] ** It is acceleration change when a 5th order functional speed change curve and ** carry out 5th order functional speed change. Although the speed change curve is similar with the 3rd order functional speed change curve, the inclination of the first half and the second half is small a little, and the inclination for the inclination in middle to be large is seen. In the graph of acceleration, although the middle acceleration peak is large compared with **, it increased from acceleration 0 gradually by the acceleration start, the completion of acceleration is also returning to 0 gradually, and it can be said that it is continuous. That is, since it comes to change continuously the driving force for making this speed change curve trace like the curve of **, it is more natural and few control of a loss is attained.

[0053] Drawing 15 is the same method as the result of drawing 6 , is the method of giving a "speed instruction value" with the 5th order functional speed change curve of ** of drawing 1 , and leading it to 600 mm/sec of target speed, and is the result of carrying out a simulation by MatLAB/Simulink. In addition, parameters other than speed instructions are made the same as a view 6. The part which has been improved by drawing 6 and where speed change showed the shape of a stairway during acceleration becomes still smoother, and it turns out that much more improvement is found. Moreover, the amount of overshoot after reaching target speed has also decreased.

[0054] Next, how to ask for a 5th order functional speed change instruction curve is explained. For example, conditions are assumed as follows.

(a) Initial velocity is 0 mm/sec.

(b) Acceleration is completed by 20mm scan.

(c) Target speed is 600 mm/sec.
(d) The acceleration at the time of an acceleration start and the completion of acceleration is 0.
(e) The differential value of acceleration is also 0 at the time of an acceleration start and the completion of acceleration.
[0055] When speed (v) is set with v=at5+bt4+ct3+dt2+et+f, from conditions (a) as 5th function of time (t) by t= 0 It is v= 0, therefore since f= 0 acceleration (alpha) is the differential of speed, it is t= 0 from alpha=v'=5at4+4bt3+3ct2+2 dt+e condition (d), and is alpha= 0. Therefore, when the differential of e= 0 acceleration is taken, it is t= 0 from alpha'=20at3+12bt2+6ct+2d condition (e), and is alpha'=0. Therefore, it is the completion time of d=0 acceleration t1 It carries out. From conditions (d), it is t=t1. It is alpha= 0. It follows. 0=5at1 4+4bt1 3+3ct12 ..... It is t=t1 from ** conditions (c). It is v= 600. It follows. 600=at15+bt14+ct13 ..... Since it is the integration of speed (v), ** scanning distance (x) is t=t1 from x=integralvdt=(a/4) t4+(b/3) t3 conditions (b). It is x= 20. It follows. 20=(a/6) t16+(b/5) t15+(c/4) t14 .. It is t=t1 from ** conditions (e). It is alpha'=0. It follows. 0=20at13+12bt12+6ct1 ..... It will be set to t1 =1/15, a= 2733750000, b=-455625000, and c= 20250000, if ****, **, **, and ** formula are allied and it solves.
[0056] Drawing 16 is a typical graph about change of the differential (alpha') of the scanning distance (x) expressed with the formula of the 5th order functional speed instruction curve for which it asked as mentioned above, speed (v), acceleration (alpha), and acceleration. Change of the acceleration when carrying out 5th order functional speed change increased from acceleration 0 gradually by the acceleration start, the completion of acceleration is also returning to 0 gradually, and it can be said that it is continuous. The graph of the differential (alpha') of acceleration understands this clearly also from it being continuation.
[0057] (others -- example) although the example made into the driving source explained the DC motor in the example 1, the main point of this invention is not limited to this
[0058] In the example 1, although the rotary type motor explained, the main point of this invention is not limited to this. A linear type motor may be used.
[0059] In the example 1, although closed loop control explained, the main point of this invention is not limited to this. Open loop control is sufficient.
[0060] In the example 1, although the speed instruction curve was explained as a 5th order functional curve, the main point of this invention was not limited to this. For example, even if it is the curve made with the still higher order function or the function using the trigonometric function, the acceleration change curve which differentiated it should just change continuously and smoothly.
[0061] Although the so-called speed control which gives a speed instruction curve, feeds back speed and calculates the generating power of a driving source from a speed error explained in the example 1, the main point of this invention is not limited to this. For example, even if it is the so-called position control which gives the position instruction curve corresponding to time, the instruction curve should just be the instructions which carry out a "smooth force change which it is continuous and is cut" demand at carriage.
[0062] this invention -- "-- an acceleration change curve, i.e., the force to accelerate, -- continuation -- and it is made to increase smoothly -- also let the control-work "control aiming at the amendment to a statical friction load" which is described below based on the idea " be criteria
[0063] Speed instructions are emitted, and the movement of actual carriage does not begin a scan immediately, but it is still in a idle state for about 0.02 seconds so that drawing 15 of the example of this invention may also show. This is because it is in the state where the statical friction load which has prevented carriage from moving is not overcome, although the torque generated on a motor is increasing gradually as a speed instruction value becomes large and goes gradually from 0.
[0064] then, the acceleration curve which it can already read that the speed instruction value has reached 50 mm/sec in drawing 15 when carriage begins to scan in about 0.02 seconds, and is the differential of a 5th order functional acceleration curve from ** of drawing 1 further -- 600 mm/sec2 **** -- it reaches and gets down utterly, and it is visible as if it had already reached the maximum inclination at the inclination
[0065] That is, the rate of the increase in the force of accelerating carriage when carriage begins to scan is not already 0, rather, will be quite large and will not have started from 0 smoothly like the change for

nearly 0 second of ** of drawing 1 . Always, from the force which a motor emits, the force of accelerating carriage is the amount which reduced a part for a friction load, and can say that how to give the force in which existence of the static friction is desirable has prevented. Therefore, it is thought like the simulation result of drawing 15 that the part which a still more nearly stair-like speed does not have in the middle of acceleration will remain.

[0066] It considers as the control method of improving the above troubles, for example, the following methods can be considered. It is the method of not giving speed instructions until carriage begins a scan. After the instruction which begins a scan is the fixed increase rate of a grade which can reach the level to which the force emitted from a motor can overcome the static friction in about 0.1 seconds, and increases the force comparatively slowly. How to apply the motor generating force continuously and smoothly on the basis of the motor generating force when carriage begins to scan slightly can be considered. According to this method, smooth acceleration is more expectable.

[0067] In the example 1, although carriage scanning control of an ink jet printer explained, the main point of this invention is not limited to this. For example, you may be control of a scanner scan of a flat bed scanner etc.

[0068]

[Effect of the Invention] As explained above, according to this invention, carriage acceleration distance with the high silence which replies to the demand of high-definition-izing and high-resolution-izing and which suppressed the noise at the time of an acceleration scan and vibration especially at the time of a carriage scan when the ink drop impact precision in the fixed-speed field just behind an acceleration field is especially high is short, and the miniaturized ink-jet recording device is obtained.

[Translation done.]

* NOTICES *

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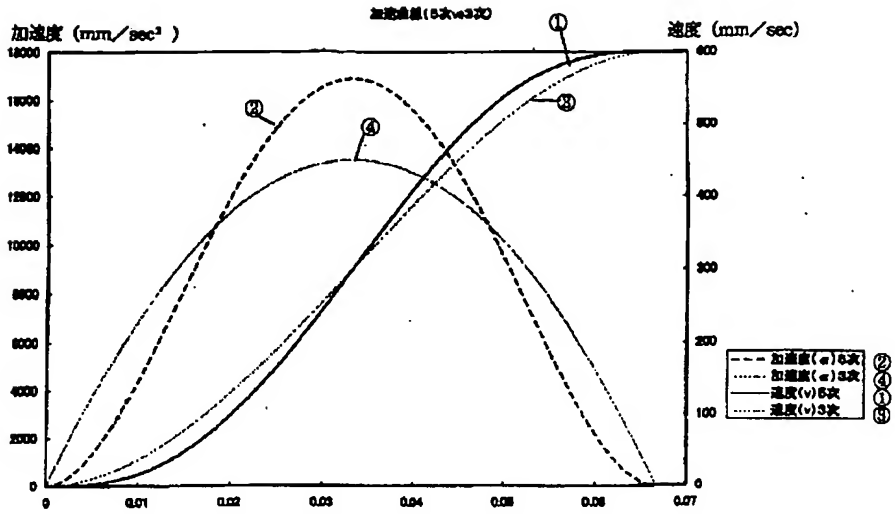
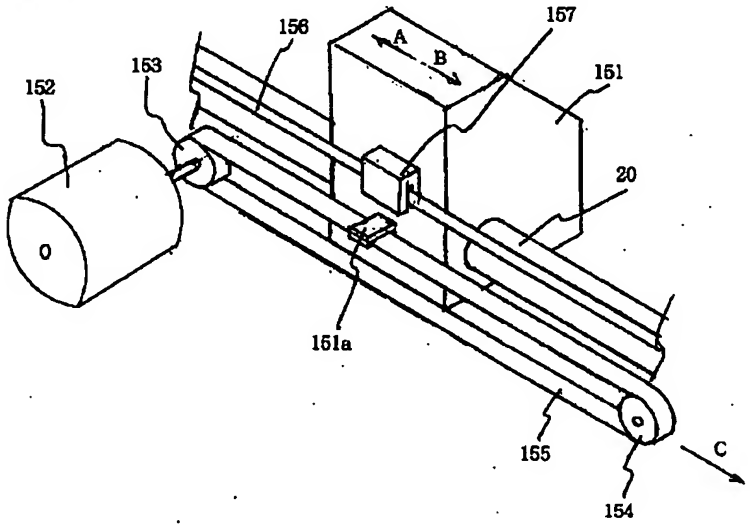
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

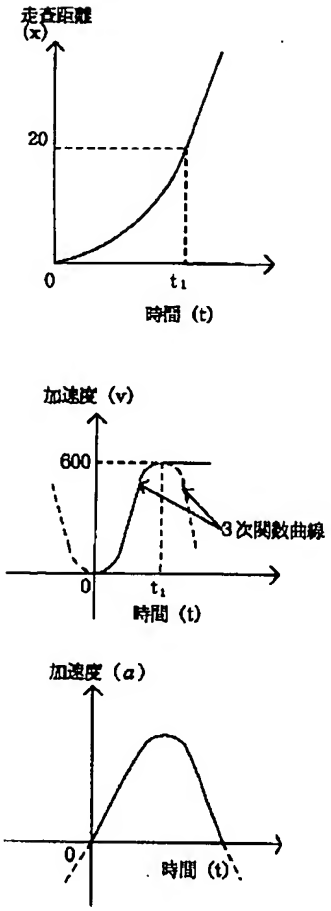
[Drawing 1]



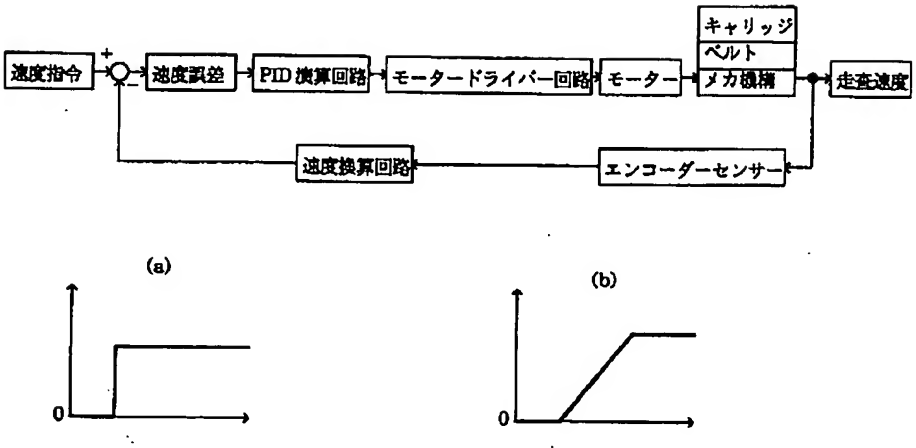
[Drawing 2]



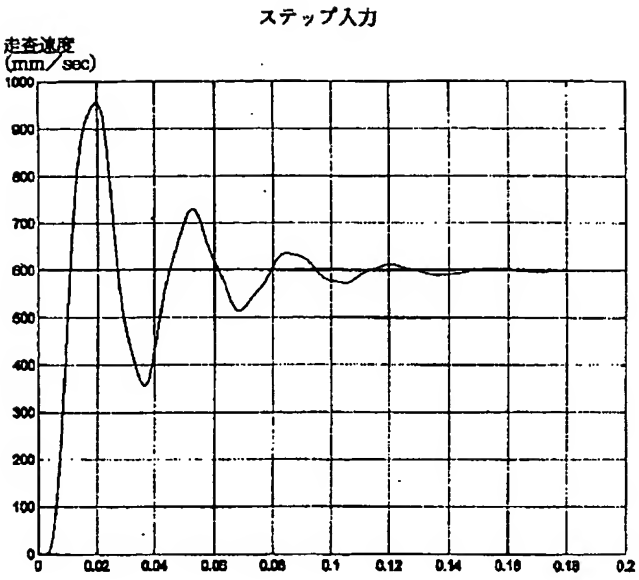
[Drawing 7]



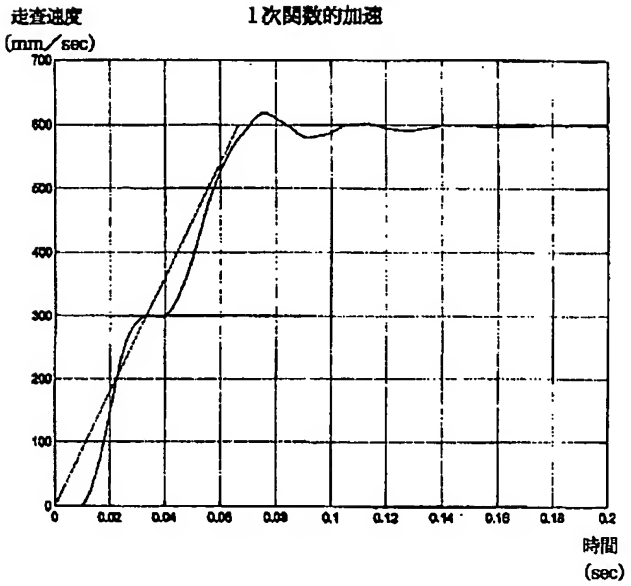
[Drawing 3]



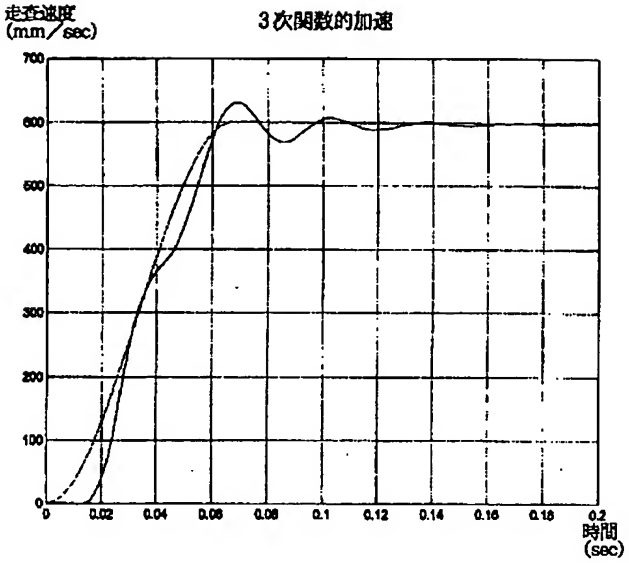
[Drawing 4]



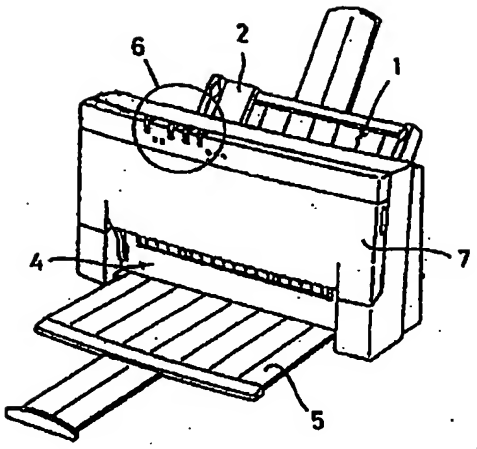
[Drawing 5]



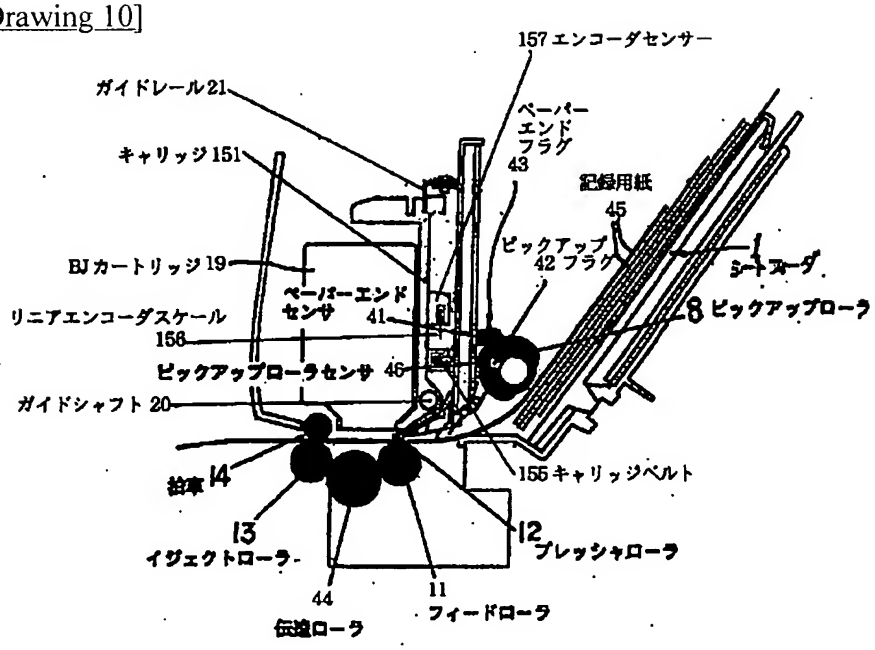
[Drawing 6]


走査速度
(mm／sec)
3次関数的加速
700
600
500
400
300
200
100
0
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
0.18
0.2
時間
(sec)

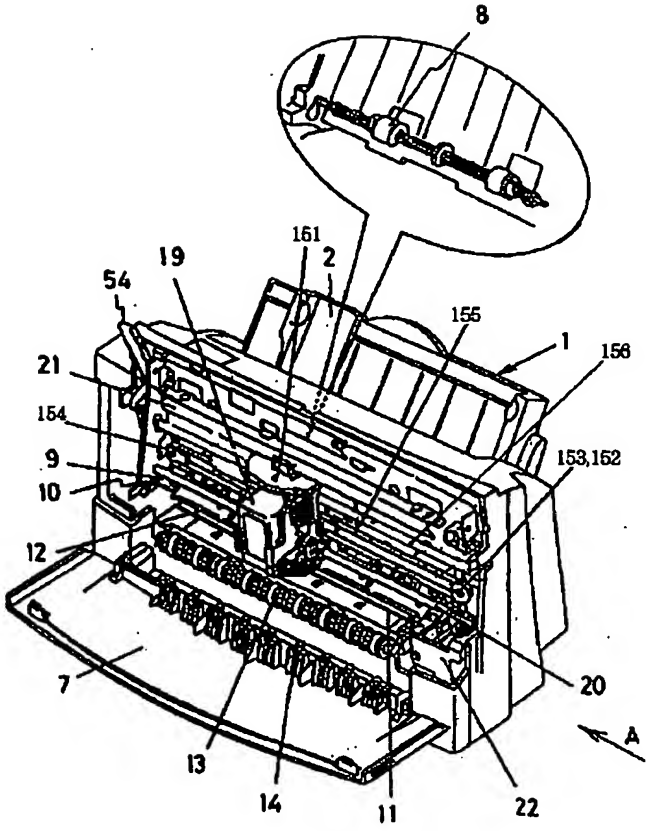
[Drawing 8]



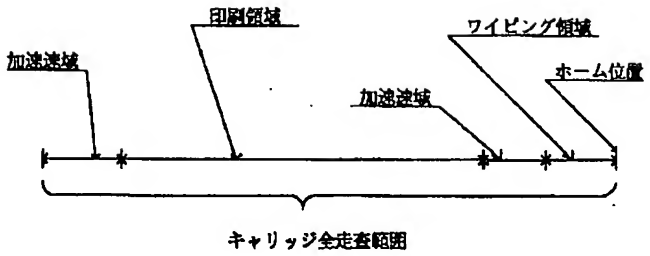
[Drawing 10]



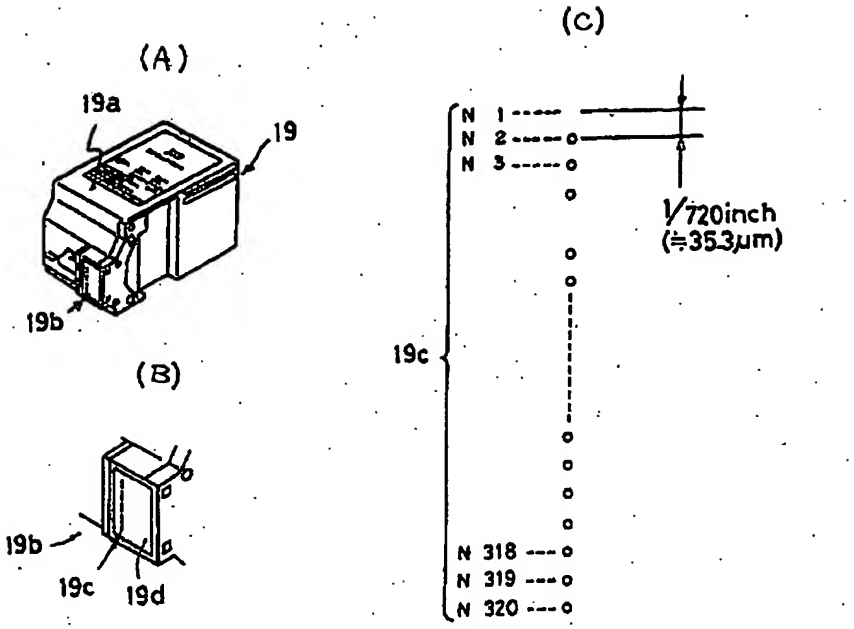
[Drawing 9]



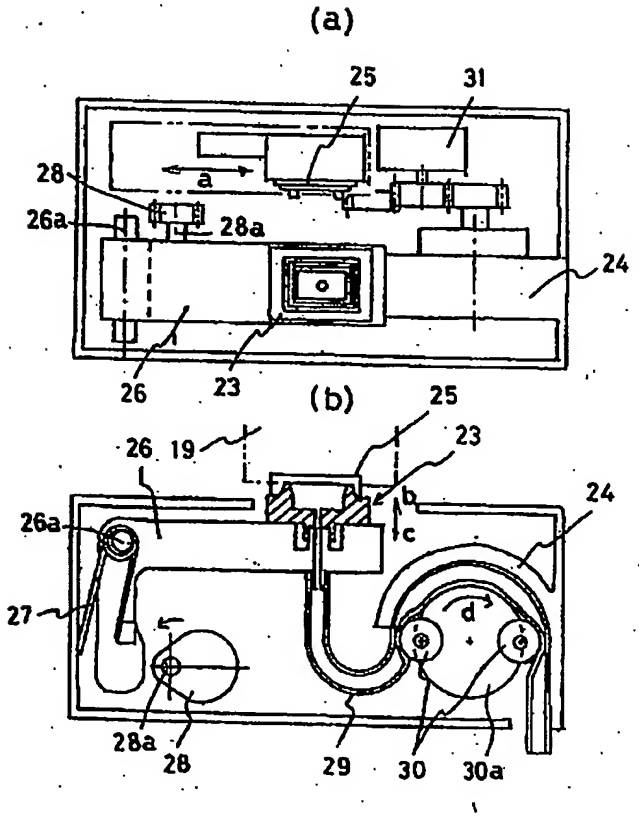
[Drawing 11]



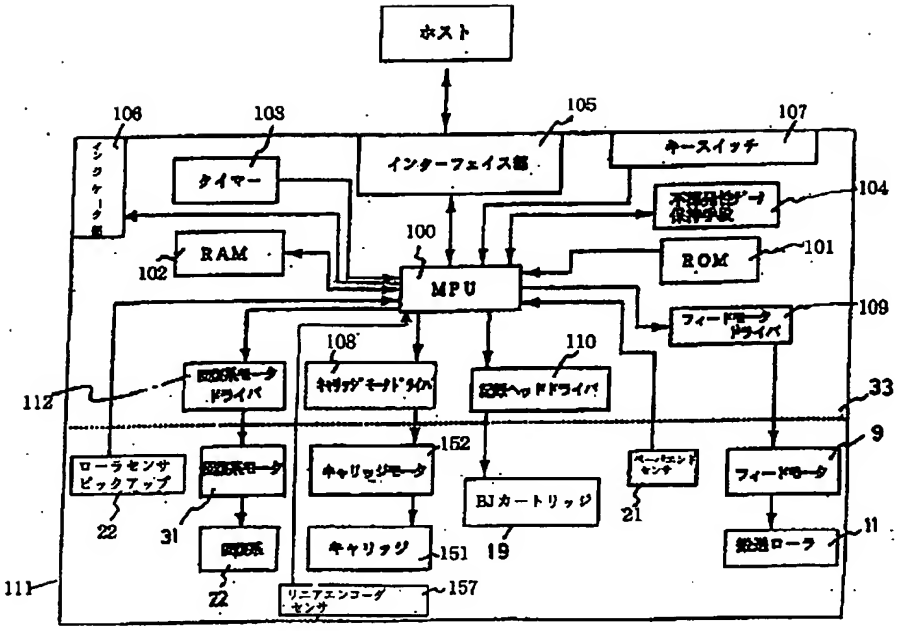
[Drawing 12]



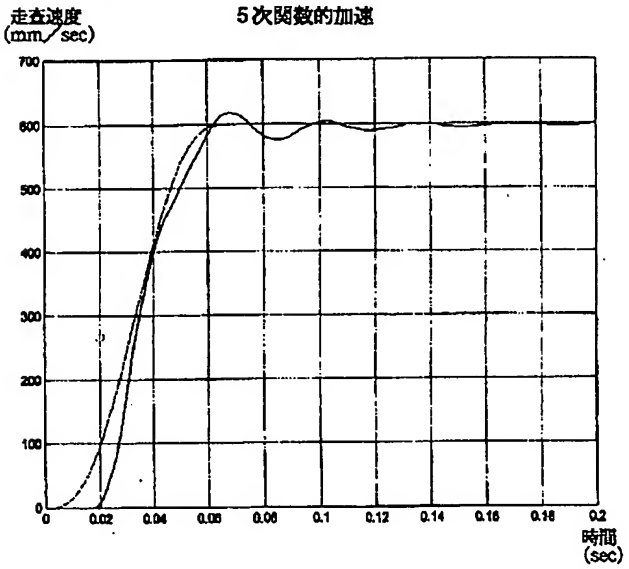
[Drawing 13]



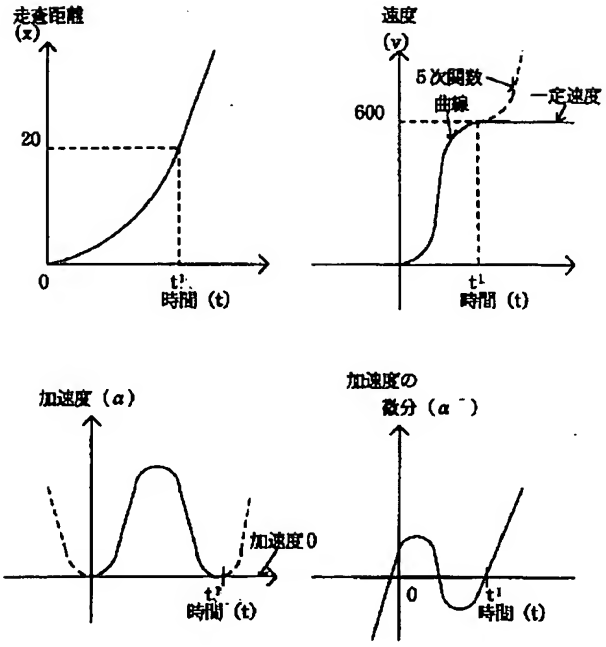
[Drawing 14]



[Drawing 15]



[Drawing 16]



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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] Drawing 1 is the graph of the speed instruction curve of carriage scanning acceleration control of the serial formula ink-jet recording device of the example of this invention, and acceleration change.
[Drawing 2] Drawing 2 is a perspective diagram explaining the composition of the conventional carriage drive system.
[Drawing 3] Drawing 3 is the conventional KYURIJJI scanning speed-control system ** type view.
[Drawing 4] Drawing 4 is the conventional carriage scan speed change graph (step-like speed instructions).
[Drawing 5] Drawing 5 is the conventional carriage scan speed change graph (1st order functional speed instructions).
[Drawing 6] Drawing 6 is the conventional carriage scan speed change graph (3rd order functional speed instructions).
[Drawing 7] Drawing 7 is the graph of the runner distance over time found with the conventional 3rd order functional speed instruction curve, speed, and acceleration.
[Drawing 8] Drawing 8 is the appearance perspective diagram of the ink-jet recording device of the example of this invention.
[Drawing 9] Drawing 9 is a transillumination perspective diagram explaining the function of each part of an ink-jet recording device of the example of this invention.
[Drawing 10] Drawing 10 is drawing of longitudinal section of the ink-jet recording device of the example of this invention.
[Drawing 11] Drawing 11 is scanning-zone explanatory drawing of the carriage of the ink-jet recording device of the example of this invention.
[Drawing 12] Drawing 12 is the external view and elements on larger scale of an example of BJ cartridge. [of this invention] [of an ink-jet recording device]
[Drawing 13] Drawing 13 is the recovery system unit configuration view of the ink-jet recording device of the example of this invention.
[Drawing 14] Drawing 14 is the block diagram showing the composition of the electric section to the Lord of the ink-jet recording device of the example of this invention.
[Drawing 15] Drawing 15 is the carriage scan speed change graph (5th order functional speed instructions) of the ink-jet recording device of the example of this invention.
[Drawing 16] Drawing 16 is the graph of the differential of the runner distance over time which the 5th order functional speed instruction curve of carriage scan speed control of the ink-jet recording device of the example of this invention found, speed, acceleration, and acceleration.
[Description of Notations]
1 Cut Sheet Feeder
2 Sheet Guide
4 Delivery Mouth
5 Delivery Tray
6 Control Panel
7 Front Cover

8 Pickup Roller
9 Paper Feed Motor
10 Slowdown Gear
11 Paper Feed Roller
12 Pressure Roller
13 Ink-Jet Roller
14 Spur
19 BJ Cartridge
20 Guide Shaft
21 Guide Rail
22 Recovery System Unit
23 Cap
24 Pump
25 Blade
26 Cap Electrode Holder
27 Cap Spring
28 Cap Release Cam
29 Tube
30 Pump Koro
41 Paper En Sensor
42 Pickup Flag
43 Paper and Flag
44 Transfer Roller
45 Record Form
46 Pickup Roller Sensor
111 Control Board
100 MPU
101 ROM
102 RAM
103 Timer
104 Nonvolatile Data-hold Meanses (EEPROM Etc.)
105 Interface Section
106 Indicator Section
107 Key Switch
108 Carriage Motor Driver
109 Paper Feed Motor Driver
110 Recording Head Driver
112 Recovery System Motor Driver
151 Carriage
152 DC Motor
153 Drive Pulley
154 Idler Pulley
155 Rubber Belt
156 Linear Encoder Scale
157 Linear Encoder Sensor

[Translation done.]